

METHOD AND APPARATUS FOR MODELING BUSINESS PROCESSES

FIELD OF THE INVENTION

This invention relates to the field of business processes. In particular, this invention is drawn to predicting the economic impact of changes in business policies.

BACKGROUND OF THE INVENTION

Businesses must be able to accurately predict or forecast events that affect the economic state of the business. Accurately predicting demand for a product, for example, is necessary in order to match production with demand. Underestimating demand results in lost sales. Overestimation of demand results in unrealized sales and associated carrying costs. Changes in business policies may undesirably impact the actual demand and the certainty of any predictions in demand and thus the financial state of the business.

Types of policy changes that can result in changes to the financial state of the business include but are not limited to sales pricing changes, advertising changes, and return policy changes. Lowering the price of the product directly, providing a rebate to the customer, or providing financial incentives to the seller are examples of sales techniques that may affect sales, returns, and profits. Accurately predicting the effect of policy changes is critical to the financial well-being of the business. Ideally the business would like to accurately predict consumer behavior with respect

to its services or products in view of sales, advertising, returns, rebate, warranty, or other policies.

Although the economic effect of policy changes can be tested in the actual marketplace, such testing may result in significant costs to the business in the case of failure. The business may experience significant financial loss, lost sales, and lost market share when the policies are tested in the actual marketplace. Thus the cost of experimentation may be exorbitant. Moreover, the product life cycle of some products may be so short that experimentation is futile. By the time an optimal policy is identified, the product has been obsolesced.

Instead of testing policies in the marketplace, simulation software may be used to model the business. Various experimental economics simulation software packages have been developed to model specific types of business organizational structures and the economic effects of policies supporting those organizational structures. One disadvantage of such systems is that they have limited ability to simulate types of business processes and models that are not already pre-defined within the software package. For example, an auction based software simulation system cannot simulate the effects of return policies.

Another disadvantage of these systems is their limited adaptive flexibility. If a process or policy rule is changed, substantial programming may be required to effect the appropriate change in software code. Rule substitution, modification, elimination or introduction is generally not possible without significant programming effort. Generally, the

experimenter must choose the individual software package that most closely matches the business processes. Significant policy changes may otherwise require a change of experimental economics simulation software packages.

5 SUMMARY OF THE INVENTION

In view of limitations of known systems and methods, methods and apparatus for determining or predicting the behavioral outcome resulting from implementation of a set of business rules are provided.

A method of determining the behavioral outcome resulting from a
10 business rule includes the step of defining at least one player, business rules, and an environment that defines actions that the player can take in accordance with the business rules. The definitions are translated into a codified script. The behavioral outcome resulting from player-selected actions during execution of the codified script are determined.

15 In one embodiment, a method of predicting the economic impact of business policies includes the step of defining a plurality of players including an associated set of rules. The associated set of rules defines a possible decision space, a decision-making process tree, an information set, an outcome function, and a payoff function for each player. The player
20 definitions are translated into codified scripts. The codified scripts are executed in an interactive simulation with the players. The result of the outcome and payoff functions at the conclusion of a script or simulation

stage determines the economic impact of the business policies defined by the rules.

In one embodiment, an apparatus for determining or predicting the economic impact of business policies includes a business process definition module. The business process definition module is used to define a plurality of players including an associated set of rules defining a possible decision space, a decision-making process tree, an information set, an outcome function, and a payoff function for each player. The apparatus further comprises a script translator module for translating the player definitions into codified scripts, wherein the codified scripts define at least one simulation stage. A simulation module is provided for executing the codified scripts. The result of the outcome and payoff functions at the end of execution of the at least one script stage determines the economic impact of the business policies defined by the rules.

Other features and advantages of the present invention will be apparent from the accompanying drawings and from the detailed description that follows below.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention is illustrated by way of example and not limitation in the figures of the accompanying drawings, in which like references indicate similar elements and in which:

Figure 1 illustrates a system architecture for predicting the effect of policy changes on business processes.

Figure 2 illustrates interaction between the business model definition process and the script translation module in greater detail.

Figure 3 illustrates a method of modeling business processes and identifying the economic impact of changes to policies through simulation.

Figure 4 illustrates application of a method of modeling business processes to evaluate return policies for a various type of resellers.

Figure 5 illustrates a business flow diagram including an information set for the application of Figure 4.

DETAILED DESCRIPTION

In order to conduct experiments to predict economic behavior in an environment of changing business policies, a test environment specifying the initial economic conditions, preferences, and costs associated with the exchange of goods or services for monetary value is established as well as the economic metrics and characteristics of the simulation participants. The environment includes human subjects who are controlled through the use of monetary or other financial rewards in order to drive their decisions with proper incentives.

Figure 1 illustrates a business process modeling system. Business information database 110 provides business information to the business model definition process 120. The business model definition module determines the institution or language of market communication including bids, offers, and acceptances. The institution defines the rules

governing the exchange of information and the rules under which communications become binding contracts.

The business model definition process maps the actual business environment into eight elements: a) decision-making entities (i.e., players), b) game rules, c) possible decision space, d) business variables, e) business process flow (i.e., decision-making process tree), f) information set, g) outcome function, and h) payoff function. The terms "system," "economics system," and "environment" will be used interchangeably to describe a system of interacting decision-makers that operate under a set of game rules. The system includes the players, the game rules, the decision space, decision-making process tree, information set, outcome function, and payoff function.

The *decision-making entities* represent decision-makers or players in the environment. The function of players is to make decisions (i.e., choose an element in the decision space) in the game. In the experiments, a player or decision-maker can be a human subject or a computer.

One example of a decision-maker is a retailer in a reseller business model. Other types of retailers include national retailers, regional retailers, mass merchant firms, discount shopping clubs, and Internet retailers.

The *game rules* include the logical processes and decision limitations in the system. For example, a constraint that prevents a player from setting advertising spending greater than the player's budget is a

decision limitation. A calculation that defines the player's revenue as a product of the sales price and the unit sales is a logical process.

The *possible decision space* represents the set of decisions to be made by the decision-making entities. This entity defines the decisions to be made, but not the set of possible decision values. Prices and stocking decisions are examples of decisions to be made in a reseller model. Although each of these decision-makers may have similar decisions to make, the possible decision space may well be different among the decision-makers due to their business model.

Business variables are numerical representations of the state of the economic system including parameters, economic indicators, and accounting variables. Business variables, for example, include inventory, demand, sales, return limits, and total market size. The value of some business variables (e.g., inventory) may be varied directly by the players. Other variable values are established by the environment (e.g., demand, total market size) or indirectly as a result of the actions of one or more players (e.g., sales).

A *business process flow* or *decision-making process tree* represents the order and timing of the decisions to be made. The decision-making process tree is defined as a series of nodes connected by a directed graph. Again, the decision-making process tree may be different between different types of retailers.

The *information set* defines the information that the decision-making entities have access to at each node of the

decision-making process tree. Some information for example may only be available after certain decisions have to be made. Some business models (e.g., an Internet retailer) may have near instantaneous access to sales information that permits just in time inventory management while other types (e.g., discount shopping clubs) must purchase in bulk in anticipation of sales.

The *outcome function* determines the outcome for each decision-making entity as a function of the decision variables. Sales or return volumes, for example, are determined as a function of the decision variables. The *payoff function* is a scoring or cost function used to evaluate the outcome for each decision-making entity. The payoff function is defined with respect to the decision-making entities. Different decision-making entities may have different goals that drive their respective decision-making processes. For example, an online reseller might place a higher priority on minimizing returns while the manufacturer is attempting to maximize profit, return on investment, sheer sales volume, or revenue growth.

Historical data from database 112 is provided to calibration process 130. Examples of historical data includes price, unit sales, product features, advertising data, return rates, inventory levels, and information about business policies. The historical data can be any data that would permit the calibration engine to make reasonable inferences about the payoff and output functions in view of the business organizational structure.

The calibration process 120 receives historical information about the same or comparable products or services. The information is organized to enable differentiation of the empirical data based on the business organizational structure. The calibration process is used to determine the values of some business variables used in the simulation to ensure the qualitative accuracy of the payoff and output functions.

The script translation process 140 receives the output of the business model definition process 120, the calibration process 130, and scenario definition data from database 170. The script translation process translates the output of the model definition process 120 and the calibration process 130 into a codified business model script 142. This script is a working model.

Variations of the codified business model script are generated based on pre-defined scenarios from the scenario definition database 170. The scenario definitions provide boundary conditions for the simulation as a whole (e.g., total market) as well as for the individual players (e.g., available budgets for inventory, purchase, etc.)

The variations may change the boundary conditions and game rules. For example, variations may implement different minimum advertised price policies (game rules). Similarly, variations may implement different boundary conditions such as purchasing budgets, advertising effectiveness, and market sizes (boundary conditions). If necessary, the experimenter can edit the scripts 142 to adjust boundary

conditions or other parameters as desired. Scripts 142 thus include the codified business model and variations.

The scripts 142 codify the players and the substance and form of communicating data between the players and the simulator during simulation. The scripts define and enforce the rules under which the players must abide. Of course, depending upon their individual economic characteristics or business organizational model, the players may be operating under different rules. For example, the scripts may display economic charts and other economic information to a specific participant.

The scripts permit flexibility in timing rules such as when information is communicated between, to, and from the players. The scripts may act on data communicated from any player in real time. Alternatively, the scripts may condition the simulator to wait until data from all players is received before continuing.

Figure 2 illustrates the interaction between the business model definition process 220 with the script translation module 240 in greater detail. The components defined in the business model definition process 220 are made available to the script translation module for the purpose of generating executable scripts such as script 242. Script translation module 240 also receives information from the calibration process 230 and the scenario definitions database 270 as previously described. The resulting script or scripts 242 include the various player, variable, and input definitions that apply globally during the simulation. Each script includes

one or more stages of game play. Payoff calculations are performed at the end of each stage.

Referring to Figure 1, the scripts 142 are provided to simulation module 150 for script execution. The scripts are procedural in form and define one or more stages of simulation. In one embodiment, the simulation module 150 compiles the scripts on the fly (i.e., interpretive execution). Alternatively, the scripts are compiled into a data structure that an internal script engine of the simulation module can then execute. In the latter case, either the script translation module or the simulation module performs the step of compiling the script for execution by the simulation module.

At the end of an executed simulation stage, a payoff is made to the players based on their economic performance. The scripts mediate the simulation including how much money the players can earn. In one embodiment, the scripts are designed such that players define the entire retail market and play exclusively against each other. Global rules that do not change across scenarios are part of the environment and may be defined by the business model definition process as a function of the game rules. Examples of global rules that would be incorporated into the environment and that do not change across scenarios might include consumer buying behavior, manufacturer supply chain processes (e.g., ordering, delivery lead time), etc.

The actual economic simulation can be conducted using humans, automated processes (i.e., "robots"), or some combination of the two. The

simulation may be conducted as a game with monetary rewards as an incentive to the players whose actions are constrained by the rules.

The simulations rely on interactive decision-making entities as identified by the scripts. For example, the decision-making entities may be

5 human. The simulation module 150 queries the human players who make the actual decisions when prompted or when permitted.

Alternatively, an interactive simulation database 160 is used to generate the decisions when prompted by the simulation module 150. Separate scripts may also be used with the simulation engine to create automated
10 decision-making entities (i.e., computer automated players).

For human interaction, the scripts are designed to provide information to the players based upon their defined econometric metrics and type of business. Thus some economic information may be provided to some players at different times or even entirely omitted. Moreover, the
15 scripts can be configured to provide some players with competitive information about other players in order to examine the effect of business intelligence information on the economic outcome. The scripts also control an input window of time when individual players can make decisions. Depending upon whether real time decision-making is desired,
20 the scripts may be configured to change the data communication and collection intervals between the simulation module and the players.

The simulation module generates simulation data 162 resulting from execution of the codified model and variations. The simulation data includes the variables updated during simulation such as the decision

variables, calculated output and payoff results, etc. This simulation data reflects the *behavioral outcome* of the environment.

The behavioral outcome includes decisions made by the players and variable values determined directly or indirectly from the results of the decisions. For example, prices will be decisions made by players during the simulation (i.e., determined directly). Revenue can be calculated (i.e., determined indirectly) from sales price and unit sales data or determined directly if defined in the game rules and recorded in the simulation data. Thus the behavioral outcome of interest can be determined directly or indirectly from the simulation data.

The use of simulation for the codified business model and variations permits consideration of interdependent decision-makers in the process. In effect, the simulator allows consideration of events occurring at lower levels or finer granularity aspects of the business model that may in fact have significant effect on the outcome.

Although several economic simulators exist for performing simulations in a pre-determined environment and in accordance with a pre-defined institution, these systems are simply not flexible enough to support analyses under changing rules of exchange. Analysis of English, Dutch, first and second price sealed bid auctions, or uniform and discriminative price multiple unit auctions, or manufacturers stated retail price (i.e., posted pricing) with double auction trading, requires different simulators. Although the simulators might permit varying parameters to change thresholds for various actions or behaviors, the rules governing

the actions or behaviors are pre-defined such that changing policy rules (not just amounts or thresholds under the same rule) requires another economic simulator specifically created to handle the new rules.

In contrast, rule changes in the architecture of Figure 1 require only
5 modification to the business process definitions from which the script translation module may generate new scripts incorporating any new policies, policy modifications, or omitting any obsolesced policies. Significant recoding is avoided because script generation and compilation is automated. The experimenter need only directly modify the rules and
10 not the codification of the rules in order to test the economic impact of various business policies.

Examples of business policies that may be tested with the simulator include return policies, price-protection policies, and benefits or penalties contingent upon the compliance of the decision-making entities with
15 policies such as minimum advertised price (MAP) policies. Typically, the manufacturer provides market development funds to advertise the manufacturer's products when the retailer complies with a MAP policy. If the retailer does not comply, the manufacturer may withhold or reduce the market development funds or decrease the amount of products
20 shipped to the retailer.

One purpose behind a MAP policy is to protect market share. If retailers perceive that price competition for the manufacturer's products is too intense, the manufacturer will lose market share because the retailers will attempt to promote products for which price competition is not as

intense. Without simulation, however, the manufacturer may not be able to effectively predict the effect of the MAP on market share and retailer profitability. Thus simulation may be used to predict the effect of eliminating or modifying MAP policies on the manufacturer's market share or the retailer's profitability.

Simulation is also advantageous for testing policies on products with short life cycles. Many consumer electronic products such as computers, computer peripherals (e.g., storage devices such as disk drives and tape drives, printers), digital cameras, etc., have such short life cycles that collection of empirical data for the purpose of making policy changes for future sales is futile. The product life cycle has already expired by the time data is collected and analyzed to create or modify business policies.

The business process modeling simulator may be analogized to a wind tunnel. A wind tunnel is used to test aerodynamic properties of scaled physical objects under specific atmospheric conditions. The atmospheric conditions may easily be controlled by the wind tunnel. Scaled versions of the physical object permit rapid modification for further testing. For example, the experimenter may lengthen or shorten wings, change attack angles, change shape, or otherwise change the model to test the performance under various atmospheric conditions. The alternative is to build a full-size version of the physical object. Without a wind tunnel, a geographic location experiencing the conditions that the object is to be tested under must be found so that the object can be moved to that geographic location for testing.

Obviously, the use of a wind tunnel allows controlled atmospheric conditions for testing at the whim of the experimenter and the use of a scaled model permits rapid prototyping and reduces the time and expense otherwise associated with building and testing full-size versions of the physical object without the use of a wind tunnel. The wind tunnel also avoids the risk (e.g., loss of life) that might otherwise be anticipated if testing with the full-size version is required.

Analogous to a wind tunnel and scaled physical models, the business process modeler similarly permits testing the economic impact of business policies or to discriminate between the economic effects of different policies without the risk, effort, or time otherwise required to test the policy in the actual marketplace (e.g., time, financial loss, loss of market share, other economic harm).

Figure 3 illustrates a method of determining the economic impact of codifiable business policies through simulation. In step 310, one or more players and an associated set of rules are defined. The rules define player economic behavior including decision space, decision-making process tree, information set, outcome function, and payoff function. In step 320, calibration data for qualifying the outcome and payoff functions is provided from empirical data. In step 330, scenarios defining rule variations and boundary conditions are provided.

In step 340, codified scripts and script variations are generated from the player definitions, calibration data, and scenario definitions. The generated scripts define one or more simulation stages. The scripts are

converted or compiled into data structures suitable for execution by a simulation module.

In step 350, an interactive simulation is executed using the scripts and the one or more players. The interaction between the players and information communicated between the players and the simulator are governed by the simulator. In step 360, the economic impact of the set of rules (i.e., defined business policies) is determined from the results of the outcome and payoff functions at the conclusion of the simulation stage. The players may be financially rewarded for example by currency based on their performance as determined by the payoff and outcome functions.

Figure 4 illustrates application of the method of Figure 3 to evaluation of a return policy in a reseller business model. Various elements of the business model definition process 420 are defined in the context of a market of resellers. The decision-making entities are defined as some combination of resellers. For example, resellers might be chosen from a variety of reseller types including club, internet, national, regional, and mass merchant resellers. In this example, 3 resellers (players) are selected. Examples of game rules include limitations on reseller advertising spending, minimum advertised price, etc. Game rules might also include supply chain processes such as lead time delays, supply chain network, etc.

In a reseller context, the decision space for the individual resellers includes prices, orders, and returns. Business variables include inventory, demand, sales, return limits, and total market size. The outcome function

involves calculation of the reseller profit and definition of a policy resolution function. If there is a restocking fee, for example, the outcome will include the costs due to restocking fees. The payoff function is defined based on the metric goals of the resellers. Thus some players may have a payoff based on net income while others have more sophisticated metrics such as revenue times the ratio of gross profit to total inventory value.

The business process flow and information set for the reseller context are illustrated in Figure 5 and generally illustrate data flow between the players and the system during simulation. As indicated in step 510, the players are presented with information on past prices, potential market size, and inventory levels. The players are permitted to set prices and to order more inventory.

In step 520, the system calculates demand and sales volume for the individual resellers resulting from the orders fulfilled on the player-selected prices. This information is presented to the player along with an indication of the remaining inventory. The player is permitted to set the number of returns to be accepted.

In step 530, the outcome is calculated in view of the player's actions and the return and price protection policies in effect. Calculating the outcome requires calculating the resulting effects of the policies such as inventory adjustment, restocking fee charges, depletion of a return credit (some return policies may entitle a retailer only to return credits previously earned by purchases), etc. The payoff can then be calculated and

displayed. Steps 510-530 may then be repeated to determine economic performance over several time periods.

Although examples were presented in the context of simulating the economic impact of a manufacturer's advertised price policy, the process
5 may be applied to simulate the economic impact or the behavioral outcome resulting from a variety of other business policies including contractual clauses. For example, the process may be applied for business modeling, contract design, modeling markets and rules of markets, auctions, stock market, and internal organizations of a company.

10 In the preceding detailed description, the invention is described with reference to specific exemplary embodiments thereof. Various modifications and changes may be made thereto without departing from the broader spirit and scope of the invention as set forth in the claims. The specification and drawings are, accordingly, to be regarded in an
15 illustrative rather than a restrictive sense.